Trace elements in the hair

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INTRODUCTION

- **Bulk hair analysis has been utilized for biomonitoring for a long time.**
- **However there are no accepted values for the concentration of trace elements in hair due to the large range (Table1).**

Table 1 Examples of trace elements in human hair [1]

Element	Published ranges (mg/kg)
Fe	3–2400
Mg	1.5–1412
Mn	0.03–81.5
Sr	0.01–860

- **The reason is that trace elements in hair have two sources:**
  - **— Physiological (endogenous)**
  - **— Environmental (exogenous)**
- **Preliminary study shows environmental signal accumulates in hair skin and some elements can diffuse into the hair (Fig. 1).**
- **The heterogeneity of trace elements distribution is due to the structure of hair (Fig. 2&3).**

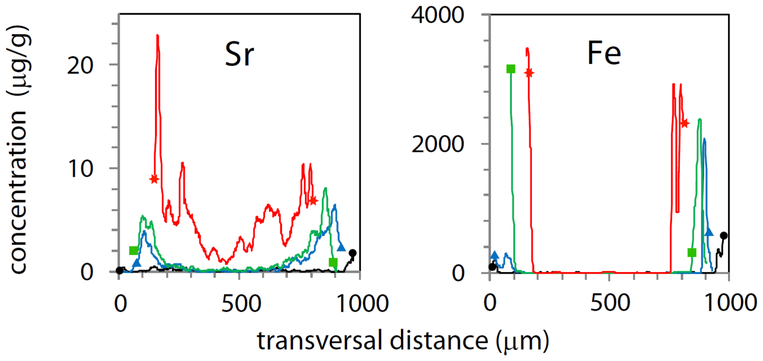

Figure 1 Estimated Sr and Fe concentration of an elephant hair at increasing distance from the base : 9.5 mm (black), 49 mm (blue), 76 mm (green) and 149 mm (red). [2]

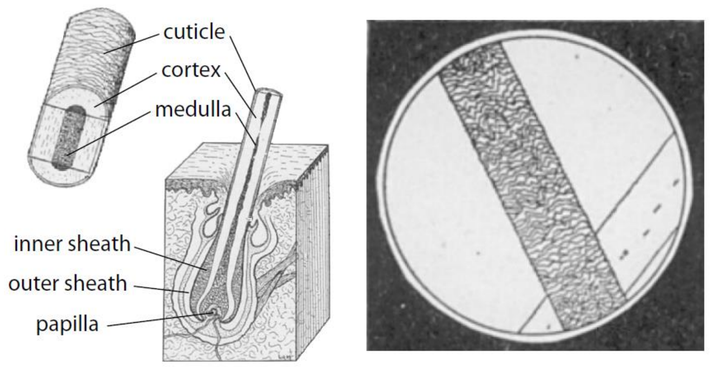

Figure 2 Hair structure from [2]

Figure 3 Micro-CT scan images for two sections of elephant hair at 2 cm (left) and 48 cm (right) from base. The white color represents the highest density of the hair. [2]

- **Therefore, we need detailed study to identify physiological and environmental signals to provide reliable information for research of**
  - **— Biomonitoring**
  - **— Environmental contamination**
  - **— Diet and migration**

METHODS

- **Physical removal of hair skin: polish away the hair skin and compare internal with bulk hair.**
- **One elephant hair was chosen for its thickness and then it was polished as shown in Fig. 5.**
- **All six sections were digested in microwave digester and the concentration of trace elements was measured by ICP-MS (Fig.6).**

Figure 4 Comparison of thickness between zebra (A), giraffe (B), and elephant (C) hair.

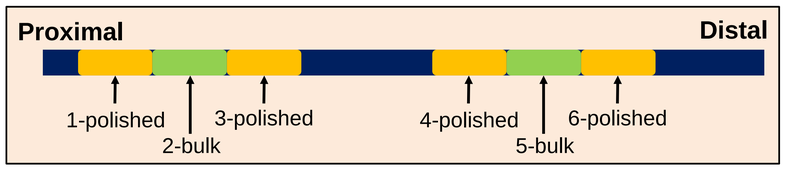

Figure 5 Schematic diagram of polishing position

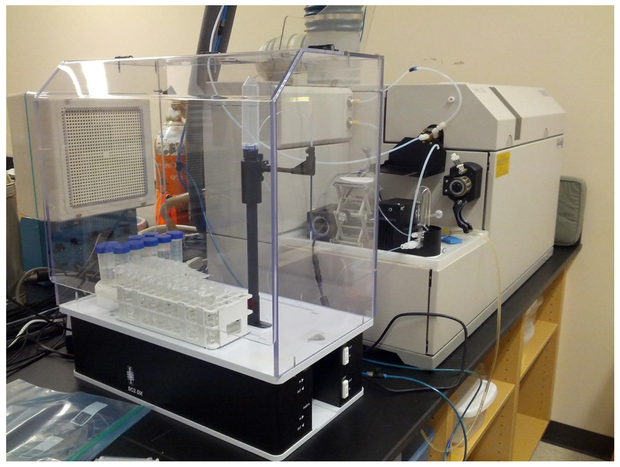

Figure 6 Agilent ICP-MS

RESULTS and DISCUSSION

- **For most elements, bulk concentration is higher than internal concentration.**
- **Elements can be roughly divided into “insoluble”, “less insoluble” and “soluble” elements (Fig. 7, 8 & 9).**
- **The comparison between two keratin material: hair and horns shows: (1) Alkaline earth and V in hair are slightly higher than in horns or at the high end of horn range; (2) Cr, Mn and Ni are a lot higher in hair; (3) Other elements are similar.**

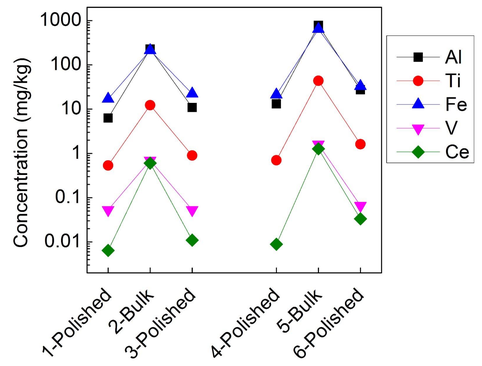

Figure 7 Insoluble elements. Bulk concentration is at least one order of magnitude higher than internal.

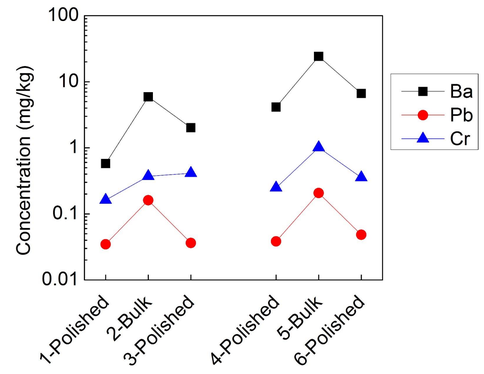

Figure 8 Less insoluble elements. Bulk concentration is about one order of magnitude higher than internal.

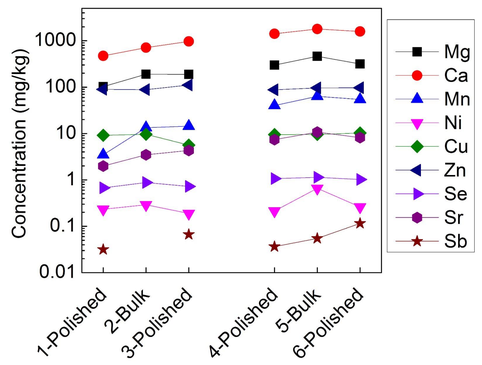

Figure 9 Soluble elements. Bulk concentration is similar to internal.

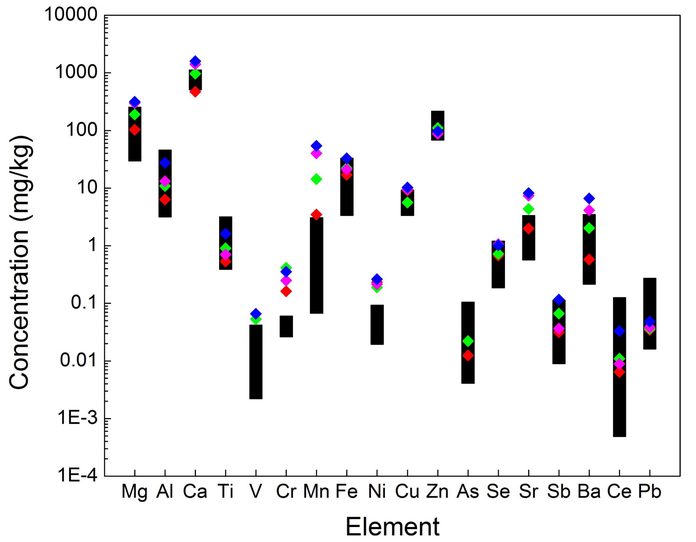

Figure 10 Comparison between polished hair and polished horns. Black bar represents the range of polished horns from different animals. Diamonds represent polished hair sections from one hair in this study.

REFERENCES

Reference

1. **Zaichick and Zaichick, *Biol Trace Elem Res* (2010) 134:41–54**
2. **Fernandez et al. (in progress)**